APPENDIX C1 TO SUBPART B OF PART 430—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF DISHWASHERS

NOTE: Prior to the compliance date for any amended energy conservation standards that incorporate standby mode and off mode energy consumption (May 30, 2013 unless the direct final rule published on May 30, 2012 is withdrawn), manufacturers may use either Appendix C or Appendix C1 to certify compliance with existing DOE energy conservation standards and to make any representations related to energy and/or water consumption of dishwashers, with the following exception. If the compliance date is after April 29, 2013, manufacturers that make representations related to standby mode and off mode energy consumption must use Appendix C1 for any representations made after April 29, 2013 of the energy and/or water consumption of these products, consistent with the requirements of 42 U.S.C. 6293(c)(2).

After the compliance date for any amended energy conservation standards that incorporate standby mode and off mode energy consumption (May 30, 2013 unless the direct final rule published on May 30, 2012 is withdrawn), all dishwashers shall be tested using the provisions of Appendix C1 to certify compliance with amended energy conservation standards and to make any representations related to energy and/or water consumption, with the following exception. If the compliance date is before April 29, 2013, manufacturers may use Appendix C for any representations until April 29, 2013 of energy and/or water consumption of these products, consistent with the requirements of 42 U.S.C. 6293(c)(2).

1. DEFINITIONS

1.1 *Active mode* means a mode in which the dishwasher is connected to a mains power source, has been activated, and is performing one of the main functions of washing, rinsing, or drying (when a drying process is included) dishware, glassware, eating utensils, and most cooking utensils by chemical, mechanical, and/or electrical means, or is involved in functions necessary for these main functions, such as admitting water into the dishwasher, pumping water out of the dishwasher, circulating air, or regenerating an internal water softener.

1.2 *AHAM* means the Association of Home Appliance Manufacturers.

1.3 *Combined low-power mode* means the aggregate of available modes other than active mode.

1.4 *Compact dishwasher* means a dishwasher that has a capacity of less than eight place settings plus six serving pieces as specified in ANSI/AHAM DW–1–2010 (incorporated

by reference; see §430.3), using the test load specified in section 2.7 of this appendix.

1.5 *Cycle* means a sequence of operations of a dishwasher which performs a complete dishwashing function, and may include variations or combinations of washing, rinsing, and drying.

1.6 *Cycle finished mode* means a standby mode which provides continuous status display following operation in active mode.

1.7 *Cycle type* means any complete sequence of operations capable of being preset on the dishwasher prior to the initiation of machine operation.

1.8 *Fan-only mode* means an active mode that is not user-selectable, and in which a fan circulates air for a finite period of time after the end of the cycle, where the end of the cycle is indicated to the consumer by means of a display, indicator light, or audible signal.

1.9 *IEC 62301* means the standard published by the International Electrotechnical Commission, titled ''Household electrical appliances-Measurement of standby power,'' Publication 62301 (Edition 2.0, 2011–01) (incorporated by reference; see §430.3).

1.10 *Inactive mode* means a standby mode that facilitates the activation of active mode by remote switch (including remote control), internal sensor, or timer, or that provides continuous status display.

1.11 *Non-soil-sensing dishwasher* means a dishwasher that does not have the ability to adjust automatically any energy consuming aspect of the normal cycle based on the soil load of the dishes.

1.12 *Normal cycle* means the cycle type, including washing and drying temperature options, recommended in the manufacturer's instructions for daily, regular, or typical use to completely wash a full load of normally soiled dishes including the power-dry feature. If no cycle or more than one cycle is recommended in the manufacturer's instructions for daily, regular, or typical use to completely wash a full load of normally soiled dishes, the most energy intensive of these cycles shall be considered the normal cycle. In the absence of a manufacturer recommendation on washing and drying temperature options, the highest energy consumption options must be selected.

1.13 *Off mode* means a mode in which the dishwasher is connected to a mains power source and is not providing any active mode or standby mode function, and where the mode may persist for an indefinite time. An indicator that only shows the user that the product is in the off position is included within the classification of an off mode.

1.14 *Power-dry feature* means the introduction of electrically-generated heat into the washing chamber for the purpose of improving the drying performance of the dishwasher.

1.15 *Preconditioning cycle* means a normal cycle run with no test load to ensure that the water lines and sump area of the pump are primed.

1.16 *Sensor heavy response* means, for standard dishwashers, the set of operations in a soil-sensing dishwasher for completely washing a load of dishes, four place settings of which are soiled according to ANSI/AHAM DW–1–2010 (incorporated by reference; see §430.3) and as additionally specified in section 2.7 of this appendix. For compact dishwashers, this definition is the same, except that two soiled place settings are used instead of four.

1.17 *Sensor light response* means, for both standard and compact dishwashers, the set of operations in a soil-sensing dishwasher for completely washing a load of dishes, one place setting of which is soiled with half of the gram weight of soils for each item specified in a single place setting according to ANSI/AHAM DW–1–2010 (incorporated by reference; see §430.3) and as additionally specified in section 2.7 of this appendix.

1.18 *Sensor medium response* means, for standard dishwashers, the set of operations in a soil-sensing dishwasher for completely washing a load of dishes, two place settings of which are soiled according to ANSI/AHAM DW–1–2010 (incorporated by reference; see §430.3) and as additionally specified in section 2.7 of this appendix. For compact dishwashers, this definition is the same, except that one soiled place setting is used instead of two.

1.19 *Soil-sensing dishwasher* means a dishwasher that has the ability to adjust any energy-consuming aspect of the normal cycle based on the soil load of the dishes.

1.20 *Standard dishwasher* means a dishwasher that has a capacity equal to or greater than eight place settings plus six serving pieces as specified in ANSI/AHAM DW–1–2010 (incorporated by reference; see §430.3), using the test load specified in section 2.7 of this appendix.

1.21 *Standby mode* means a mode in which the dishwasher is connected to a mains power source and offers one or more of the following user-oriented or protective functions which may persist for an indefinite time: (a) To facilitate the activation of other modes (including activation or deactivation of active mode) by remote switch (including remote control), internal sensor, or timer; (b) continuous functions, including information or status displays (including clocks) or sensor-based functions. A timer is a continuous clock function (which may or may not be associated with a display) that provides regular scheduled tasks (*e.g.*, switching) and that operates on a continuous basis.

1.22 *Truncated normal cycle* means the normal cycle interrupted to eliminate the power-dry feature after the termination of the last rinse operation.

1.23 *Truncated sensor heavy response* means the sensor heavy response interrupted to eliminate the power-dry feature after the termination of the last rinse operation.

1.24 *Truncated sensor light response* means the sensor light response interrupted to eliminate the power-dry feature after the termination of the last rinse operation.

1.25 *Truncated sensor medium response* means the sensor medium response interrupted to eliminate the power-dry feature after the termination of the last rinse operation.

1.26 *Water-heating dishwasher* means a dishwasher which, as recommended by the manufacturer, is designed for heating cold inlet water (nominal 50 °F) or designed for heating water with a nominal inlet temperature of 120 °F. Any dishwasher designated as water-heating (50 °F or 120 °F inlet water) must provide internal water heating to above 120 °F in a least one wash phase of the normal cycle.

1.27 *Water-softening dishwasher* means a dishwasher which incorporates a water softening system that periodically consumes additional water and energy during the cycle to regenerate.

2. TESTING CONDITIONS

2.1 *Installation requirements.* Install the dishwasher according to the manufacturer's instructions, including drain height. If the manufacture does not provide instructions for a specific drain height, the drain height shall be 20 inches. The racks shall be positioned according to the manufacturer recommendation for washing a full load of normally soiled dishes, or in the absence of a recommendation, the racks shall be maintained in the as-shipped position. The rinse aid container shall remain empty. A standard or compact under-counter or under-sink dishwasher must be tested in a rectangular enclosure constructed of nominal 0.374 inch (9.5 mm) plywood painted black. The enclosure must consist of a top, a bottom, a back, and two sides. If the dishwasher includes a counter top as part of the appliance, omit the top of the enclosure. Bring the enclosure into the closest contact with the appliance that the configuration of the dishwasher will allow. For standby mode and off mode testing, these products shall also be installed in accordance with Section 5, Paragraph 5.2 of IEC 62301 (incorporated by reference; see §430.3), disregarding the provisions regarding batteries and the determination, classification, and testing of relevant modes.

2.2 *Electrical energy supply.*

2.2.1 *Dishwashers that operate with an electrical supply of 115 volts.* Maintain the electrical supply to the dishwasher at 115 volts ±2 percent and within 1 percent of the nameplate frequency as specified by the manufacturer. Maintain a continuous electrical supply to the unit throughout testing, including

the preconditioning cycles, specified in section 2.9 of this appendix, and in between all test cycles.

2.2.2 *Dishwashers that operate with an electrical supply of 240 volts.* Maintain the electrical supply to the dishwasher at 240 volts ±2 percent and within 1 percent of the nameplate frequency as specified by the manufacturer. Maintain a continuous electrical supply to the unit throughout testing, including the preconditioning cycles, specified in section 2.9 of this appendix, and in between all test cycles.

2.2.3 *Supply voltage waveform.* For the standby mode and off mode testing, maintain the electrical supply voltage waveform indicated in Section 4, Paragraph 4.3.2 of IEC 62301 (incorporated by reference; see §430.3).

2.3 *Water temperature.* Measure the temperature of the water supplied to the dishwasher using a temperature measuring device as specified in section 3.1 of this appendix.

2.3.1 *Dishwashers to be tested at a nominal 140 °F inlet water temperature.* Maintain the water supply temperature at 140° ± 2 °F.

2.3.2 *Dishwashers to be tested at a nominal 120 °F inlet water temperature.* Maintain the water supply temperature at 120° ± 2 °F.

2.3.3 *Dishwashers to be tested at a nominal 50 °F inlet water temperature.* Maintain the water supply temperature at 50° ± 2 °F.

2.4 *Water pressure.* Using a water pressure gauge as specified in section 3.4 of this appendix, maintain the pressure of the water supply at 35 ± 2.5 pounds per square inch gauge (psig) when the water is flowing. The pressure shall be achieved within 2 seconds of opening the water supply valve.

2.5 *Ambient temperature.*

2.5.1 *Active mode ambient and machine temperature.* Using a temperature measuring device as specified in section 3.1 of this appendix, maintain the room ambient air temperature at 75° ± 5 °F and ensure that the dishwasher and the test load are at room ambient temperature at the start of each test cycle.

2.5.2 *Standby mode and off mode ambient temperature.* For standby mode and off mode testing, maintain room ambient air temperature conditions as specified in Section 4, Paragraph 4.2 of IEC 62301 (incorporated by reference; see §430.3).

2.6 *Test cycle and load.*

2.6.1 *Non-soil-sensing dishwashers to be tested at a nominal inlet temperature of 140 °F.* All non-soil-sensing dishwashers to be tested according to section 4.1 of this appendix at a nominal inlet temperature of 140 °F must be tested on the normal cycle and truncated normal cycle without a test load if the dishwasher does not heat water in the normal cycle.

2.6.2 *Non-soil-sensing dishwashers to be tested at a nominal inlet temperature of 50 °F or 120 °F.* All non-soil-sensing dishwashers to be

tested according to section 4.1 of this appendix at a nominal inlet temperature of 50 °F or 120 °F must be tested on the normal cycle with a clean load of eight place settings plus six serving pieces, as specified in section 2.7 of this appendix. If the capacity of the dishwasher, as stated by the manufacturer, is less than eight place settings, then the test load must be the stated capacity.

2.6.3 *Soil-sensing dishwashers to be tested at a nominal inlet temperature of 50 °F, 120 °F, or 140 °F.* All soil-sensing dishwashers shall be tested according to section 4.1 of this appendix on the normal cycle. The dishwasher shall be tested first for the sensor heavy response, then tested for the sensor medium response, and finally for the sensor light response with the following combinations of soiled and clean test loads.

2.6.3.1 For tests of the sensor heavy response, as defined in section 1.16 of this appendix:

(A) For standard dishwashers, the test unit is to be loaded with a total of eight place settings plus six serving pieces as specified in section 2.7 of this appendix. Four of the eight place settings, except for the flatware, must be soiled according to sections 5.3 through 5.7 of ANSI/AHAM DW–1–2010 (incorporated by reference, see §430.3) and as additionally specified in sections 2.7.4 and 2.7.5 of this appendix, while the remaining place settings, serving pieces, and all flatware are not soiled. The test load is to be loaded in the dishwasher according to section 5.8 of ANSI/AHAM DW–1–2010.

(B) For compact dishwashers, the test unit is to be loaded with four place settings plus six serving pieces as specified in section 2.7 of this appendix. Two of the four place settings, except for the flatware, must be soiled according to sections 5.3 through 5.7 of ANSI/AHAM DW–1–2010 and as additionally specified in sections 2.7.4 and 2.7.5 of this appendix, while the remaining place settings, serving pieces, and all flatware are not soiled. The test load is to be loaded in the dishwasher according to section 5.8 of ANSI/AHAM DW–1–2010.

2.6.3.2 For tests of the sensor medium response, as defined in section 1.18 of this appendix:

(A) For standard dishwashers, the test unit is to be loaded with a total of eight place settings plus six serving pieces as specified in section 2.7 of this appendix. Two of the eight place settings, except for the flatware, must be soiled according to sections 5.3 through 5.7 of ANSI/AHAM DW–1–2010 (incorporated by reference, see §430.3) and as additionally specified in sections 2.7.4 and 2.7.5 of this appendix, while the remaining place settings, serving pieces, and all flatware are not soiled. The test load is to be loaded in the dishwasher according to section 5.8 of ANSI/AHAM DW–1–2010.

(B) For compact dishwashers, the test unit is to be loaded with four place settings plus six serving pieces as specified in section 2.7 of this appendix. One of the four place settings, except for the flatware, must be soiled according to sections 5.3 through 5.7 of ANSI/AHAM DW–1–2010 and as additionally specified in sections 2.7.4 and 2.7.5 of this appendix, while the remaining place settings, serving pieces, and all flatware are not soiled. The test load is to be loaded in the dishwasher according to section 5.8 of ANSI/AHAM DW–1–2010.

2.6.3.3 For tests of the sensor light response, as defined in section 1.17 of this appendix:

(A) For standard dishwashers, the test unit is to be loaded with a total of eight place settings plus six serving pieces as specified in section 2.7 of this appendix. One of the eight place settings, except for the flatware, must be soiled with half of the soil load specified for a single place setting according to sections 5.3 through 5.7 of ANSI/AHAM DW–1–

2010 (incorporated by reference, see § 430.3) and as additionally specified in sections 2.7.4 and 2.7.5 of this appendix, while the remaining place settings, serving pieces, and all flatware are not soiled. The test load is to be loaded in the dishwasher according to section 5.8 of ANSI/AHAM DW–1–2010.

(B) For compact dishwashers, the test unit is to be loaded with four place settings plus six serving pieces as specified in section 2.7 of this appendix. One of the four place settings, except for the flatware, must be soiled with half of the soil load specified for a single place setting according to sections 5.3 through 5.7 of ANSI/AHAM DW–1–2010 and as additionally specified in sections 2.7.4 and 2.7.5 of this appendix, while the remaining place settings, serving pieces, and all flatware are not soiled. The test load is to be loaded in the dishwasher according to section 5.8 of ANSI/AHAM DW–1–2010.

2.7 *Test load.*

2.7.1 *Test load items.*

Dishware/glassware/flatware item	Primary source	Description	Primary No.	Alternate source	Alternate source No.
Dinner Plate	Corning Comcor®/Corelle®.	10 inch Dinner Plate.	6003893	.	
Bread and Butter Plate.	Corning Comcor®/Corelle®.	6.75 inch Bread & Butter.	6003887	Arzberg	8500217100 or 2000–00001–0217–1
Fruit Bowl	Corning Comcor®/Corelle®.	10 oz. Dessert Bowl.	6003899	Arzberg	3820513100
Cup	Corning Comcor®/Corelle®.	8 oz. Ceramic Cup.	6014162	Arzberg	1382–00001–4732
Saucer	Corning Comcor®/Corelle®.	6 inch Saucer	6010972	Arzberg	1382–00001–4731
Serving Bowl	Corning Comcor®/Corelle®.	1 qt. Serving Bowl	6003911	.	
Platter	Corning Comcor®/Corelle®.	9.5 inch Oval Platter.	6011655	.	
Glass—Iced Tea ...	Libbey	....	551 HT	.	
Flatware—Knife	Oneida®—Accent	....	2619KPVF	WMF—Gastro 0800.	12.0803.6047
Flatware—Dinner Fork.	Oneida®—Accent	....	2619FRSF	WMF—Signum 1900.	12.1905.6040
Flatware—Salad Fork.	Oneida®—Accent	....	2619FSLF	WMF—Signum 1900.	12.1964.6040
Flatware—Teaspoon.	Oneida®—Accent	....	2619STSF	WMF—Signum 1900.	12.1910.6040
Flatware—Serving Fork.	Oneida®—Flight ..	....	2865FCM	WMF—Signum 1900.	12.1902.6040
Flatware—Serving Spoon.	Oneida®—Accent	....	2619STBF	WMF—Signum 1900.	12.1904.6040

2.7.2 *Place setting.* A place setting shall consist of one cup, one saucer, one dinner plate, one bread and butter plate, one fruit bowl, one iced tea glass, one dinner fork, one salad fork, one knife, and two teaspoons.

2.7.3 *Serving pieces.* Serving pieces shall consist of two serving bowls, one platter, one serving fork, and two serving spoons.

2.7.4 *Soils.* The soils shall be as specified in section 5.4 of ANSI/AHAM DW–1–2010 (incorporated by reference, see § 430.3), except for the following substitutions.

2.7.4.1 *Margarine.* The margarine shall be Fleischmann's Original stick margarine.

2.7.4.2 *Coffee.* The coffee shall be Folgers Classic Decaf.

2.7.5 *Soil Preparation.* Soils shall be prepared according to section 5.5 of ANSI/AHAM DW–1–2010 (incorporated by reference, see § 430.3), with the following additional specifications.

2.7.5.1 *Milk.* The nonfat dry milk shall be reconstituted before mixing with the oatmeal and potatoes. It shall be reconstituted

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with water by mixing ⅔ cup of nonfat dry milk with 2 cups of water until well mixed. The reconstituted milk may be stored for use over the course of 1 day.

2.7.5.2 *Instant mashed potatoes.* The potato mixture shall be applied within 30 minutes of preparation.

2.7.5.3 *Ground beef.* The 1-pound packages of ground beef shall be stored frozen for no more than 6 months.

2.8 *Testing requirements.* Provisions in this appendix pertaining to dishwashers that operate with a nominal inlet temperature of 50 °F or 120 °F apply only to water-heating dishwashers as defined in section 1.26 of this appendix.

2.9 *Preconditioning requirements.* Precondition the dishwasher twice by establishing the testing conditions set forth in sections 2.1 through 2.5 of this appendix. For each preconditioning, set the dishwasher to the preconditioning cycle as defined in section 1.15 of this appendix, without using a test load, and initiate the cycle. During the second preconditioning, measure the prewash fill water volume, V_{pw}, if any, and the main wash fill water volume, V_{mw}.

2.10 *Detergent.* Use half the quantity of detergent specified according to section 4.1 of ANSI/AHAM DW–1–2010 (incorporated by reference, see §430.3), using Cascade with the Grease Fighting Power of Dawn powder as the detergent formulation. Determine the amount of detergent (in grams) to be added to the prewash compartment (if provided) or elsewhere in the dishwasher (if recommended by the manufacturer) and the main wash compartment according to sections 2.10.1 and 2.10.2 of this appendix.

2.10.1 *Prewash Detergent Dosing.* If the cycle setting for the test cycle includes prewash, determine the quantity of dry prewash detergent, D_{pw}, in grams (g) that results in 0.25 percent concentration by mass in the prewash fill water as:

$$D_{pw} = V_{pw} \times \rho \times k \times 0.25/100$$

where,

V_{pw} = the prewash fill volume of water in gallons,

ρ = water density = 8.343 pounds (lb)/gallon for dishwashers to be tested at a nominal inlet water temperature of 50 °F (10 °C), 8.250 lb/gallon for dishwashers to be tested at a nominal inlet water temperature of 120 °F (49 °C), and 8.205 lb/gallon for dishwashers to be tested at a nominal inlet water temperature of 140 °F (60 °C), and

k = conversion factor from lb to g = 453.6 g/lb.

2.10.2 *Main Wash Detergent Dosing.* Determine the quantity of dry main wash detergent, D_{mw}, in grams (g) that results in 0.25 percent concentration by mass in the main wash fill water as:

$$D_{mw} = V_{mw} \times \rho \times k \times 0.25/100$$

where,

V_{mw} = the main wash fill volume of water in gallons, and

ρ, and k are defined in section 2.10.1 of this appendix.

3. INSTRUMENTATION

Test instruments must be calibrated annually.

3.1 *Temperature measuring device.* The device must have an error no greater than ± 1 °F over the range being measured.

3.2 *Timer.* Time measurements for each monitoring period shall be accurate to within 2 seconds.

3.3 *Water meter.* The water meter must have a resolution of no larger than 0.1 gallons and a maximum error no greater than ± 1.5 percent of the measured flow rate for all water temperatures encountered in the test cycle.

3.4 *Water pressure gauge.* The water pressure gauge must have a resolution of one pound per square inch (psi) and must have an error no greater than 5 percent of any measured value over the range of 35 ± 2.5 psig.

3.5 *Watt-hour meter.* The watt-hour meter must have a resolution of .1 watt-hour or less and a maximum error of no more than 1 percent of the measured value for any demand greater than 5 watts.

3.6 *Standby mode and off mode watt meter.* The watt meter used to measure standby mode and off mode power consumption shall meet the requirements specified in Section 4, Paragraph 4.4 of IEC 62301 (incorporated by reference, see §430.3).

4. TEST CYCLE AND MEASUREMENTS

4.1 *Active mode cycle.* Perform a test cycle by establishing the testing conditions set forth in section 2 of this appendix, setting the dishwasher to the cycle type to be tested according to section 2.6.1, 2.6.2, or 2.6.3 of this appendix, initiating the cycle, and allowing the cycle to proceed to completion.

4.1.1 *Machine electrical energy consumption.* Measure the machine electrical energy consumption, M, expressed as the number of kilowatt-hours of electricity consumed by the machine during the entire test cycle, using a water supply temperature as set forth in section 2.3 of this appendix and using a watt-hour meter as specified in section 3.5 of this appendix.

4.1.2 *Fan electrical energy consumption.* If the dishwasher is capable of operation in fan-only mode, measure the fan electrical energy consumption, M_F, expressed as the number of kilowatt-hours of electricity consumed by the machine for the duration of fan-only mode, using a watt-hour meter as specified in section 3.5 of this appendix. Alternatively, if the duration of fan-only mode is known, the watt-hours consumed may be measured for a period of 10 minutes in fan-only mode,

using a watt-hour meter as specified in section 3.5 of this appendix. Multiply this value by the time in minutes that the dishwasher remains in fan-only mode, L_F, and divide by 10,000 to obtain M_F. The alternative approach may be used only if the resulting M_F is representative of energy use during the entire fan-only mode.

4.1.3 *Water consumption.* Measure the water consumption, V, expressed as the number of gallons of water delivered to the machine during the entire test cycle, using a water meter specified in section 3.3 of this appendix.

4.2 *Standby mode and off mode power.* Connect the dishwasher to a standby mode and off mode watt meter as specified in section 3.6 of this appendix. Establish the testing conditions set forth in sections 2.1, 2.2, and 2.5.2 of this appendix. For dishwashers that take some time to enter a stable state from a higher power state as discussed in Section 5, Paragraph 5.1, note 1 of IEC 62301 (incorporated by reference; see §430.3), allow sufficient time for the dishwasher to reach the lower power state before proceeding with the test measurement. Follow the test procedure specified in Section 5, Paragraph 5.3.2 of IEC 62301 for testing in each possible mode as described in sections 4.2.1 and 4.2.2 of this appendix.

4.2.1 If the dishwasher has an inactive mode, as defined in section 1.10 of this appendix, measure and record the average inactive mode power of the dishwasher, P_{IA}, in watts.

4.2.2 If the dishwasher has an off mode, as defined in section 1.13 of this appendix, measure and record the average off mode power, P_{OM}, in watts.

5. CALCULATION OF DERIVED RESULTS FROM TEST MEASUREMENTS

5.1 *Machine energy consumption.*

5.1.1 *Machine energy consumption for non-soil-sensing electric dishwashers.* Take the value recorded in section 4.1.1 of this appendix as the per-cycle machine electrical energy consumption. Express the value, M, in kilowatt-hours per cycle.

5.1.2 *Machine energy consumption for soil-sensing electric dishwashers.* The machine energy consumption for the sensor normal cycle, M, is defined as:

$$M = (M_{hr} \times F_{hr}) + (M_{mr} \times F_{mr}) + (M_{lr} \times F_{lr})$$

where,

M_{hr} = the value recorded in section 4.1.1 of this appendix for the test of the sensor heavy response, expressed in kilowatt-hours per cycle,

M_{mr} = the value recorded in section 4.1.1 of this appendix for the test of the sensor medium response, expressed in kilowatt-hours per cycle,

M_{lr} = the value recorded in section 4.1.1 of this appendix for the test of the sensor

light response, expressed in kilowatt-hours per cycle,

F_{hr} = the weighting factor based on consumer use of heavy response = 0.05,

F_{mr} = the weighting factor based on consumer use of medium response = 0.33, and

F_{lr} = the weighting factor based on consumer use of light response = 0.62.

5.1.3 *Machine energy consumption during water softener regeneration for water-softening dishwashers.* The machine energy consumption for water softener regeneration, M_{WS}, is defined as:

$$M_{WS} = M_{WScycle} \times N_{WS}/N$$

where,

$M_{WScycle}$ = the reported value of the additional machine electrical energy consumption required for water softener regeneration during a cycle including water softener regeneration, expressed in kilowatt-hours,

N_{WS} = the reported representative average number of water softener regeneration cycles per year, and

N = the representative average dishwasher use of 215 cycles per year.

5.2 *Fan-only mode energy consumption.*

5.2.1 *Electrical energy consumption for fan-only mode for non-soil-sensing electric dishwashers.* Take the value recorded in section 4.1.2 of this appendix as the per-cycle electrical energy consumption for fan-only mode. Express the value, E_F, in kilowatt-hours per cycle. If the dishwasher is not capable of operation in fan-only mode, $E_F = 0$.

5.2.2 *Electrical energy consumption for fan-only mode for soil-sensing electric dishwashers.* The fan-only mode electrical energy consumption, E_F, for the sensor normal cycle is defined as:

$$E_F = (E_{Fhr} + E_{Fmr} + E_{Flr})/3$$

where,

E_{Fhr} = the value recorded in section 4.1.2 of this appendix for the test of the sensor heavy response, expressed in kilowatt-hours per cycle,

E_{Fmr} = the value recorded in section 4.1.2 of this appendix for the test of the sensor medium response, expressed in kilowatt-hours per cycle,

E_{Flr} = the value recorded in section 4.1.2 of this appendix for the test of the sensor light response, expressed in kilowatt-hours per cycle,

If the dishwasher is not capable of operation in fan-only mode, $E_F = 0$.

5.3 *Drying energy.*

5.3.1 *Drying energy consumption for non-soil-sensing electric dishwashers.* Calculate the amount of energy consumed using the power-dry feature after the termination of the last rinse option of the normal cycle. Express the value, E_D, in kilowatt-hours per cycle.

5.3.2 *Drying energy consumption for soil-sensing electric dishwashers.* The drying energy consumption, E_D, for the sensor normal cycle is defined as:

$E_D = (E_{Dhr} + E_{Dmr} + E_{Dlr})/3$

where,

E_{Dhr} = energy consumed using the power-dry feature after the termination of the last rinse option of the sensor heavy response, expressed in kilowatt-hours per cycle,

E_{Dmr} = energy consumed using the power-dry feature after the termination of the last rinse option of the sensor medium response, expressed in kilowatt-hours per cycle,

E_{Dlr} = energy consumed using the power-dry feature after the termination of the last rinse option of the sensor light response, expressed in kilowatt-hours per cycle,

5.4 *Water consumption.*

5.4.1 *Water consumption for non-soil-sensing electric dishwashers using electrically heated, gas-heated, or oil-heated water.* Take the value recorded in section 4.1.3 of this appendix as the per-cycle water consumption. Express the value, V, in gallons per cycle.

5.4.2 *Water consumption for soil-sensing electric dishwashers using electrically heated, gas-heated, or oil-heated water.* The water consumption for the sensor normal cycle, V, is defined as:

$V = (V_{hr} \times F_{hr}) + (V_{mr} \times F_{mr}) + (V_{lr} \times F_{lr})$

where,

V_{hr} = the value recorded in section 4.1.3 of this appendix for the test of the sensor heavy response, expressed in gallons per cycle,

V_{mr} = the value recorded in section 4.1.3 of this appendix for the test of the sensor medium response, expressed in gallons per cycle,

V_{lr} = the value recorded in section 4.1.3 of this appendix for the test of the sensor light response, expressed in gallons per cycle,

F_{hr} = the weighting factor based on consumer use of heavy response = 0.05,

F_{mr} = the weighting factor based on consumer use of medium response = 0.33, and

F_{lr} = the weighting factor based on consumer use of light response = 0.62.

5.4.3 *Water consumption during water softener regeneration for water-softening dishwashers using electrically heated, gas-heated, or oil-heated water.* The water consumption for water softener regeneration, V_{WS}, is defined as:

$V_{WS} = V_{WScycle} \times N_{WS}/N$

where,

$V_{WScycle}$ = the reported value of the additional water consumption required for water softener regeneration during a cycle in-

cluding water softener regeneration, expressed in gallons per cycle,

N_{WS} = the reported representative average number of water softener regeneration cycles per year, and

N = the representative average dishwasher use of 215 cycles per year.

5.5 *Water energy consumption for non-soil-sensing or soil-sensing dishwashers using electrically heated water.*

5.5.1 *Dishwashers that operate with a nominal 140 °F inlet water temperature, only.*

5.5.1.1 Calculate the water energy consumption, W, expressed in kilowatt-hours per cycle and defined as:

$W = V \times T \times K$

where,

V = water consumption in gallons per cycle, as determined in section 5.4.1 of this appendix for non-soil-sensing dishwashers and section 5.4.2 of this appendix for soil-sensing dishwashers,

T = nominal water heater temperature rise = 90 °F, and

K = specific heat of water in kilowatt-hours per gallon per degree Fahrenheit = 0.0024.

5.5.1.2 For water-softening dishwashers, calculate the water softener regeneration water energy consumption, W_{WS}, expressed in kilowatt-hours per cycle and defined as:

$W_{WS} = V_{WS} \times T \times K$

where,

V_{WS} = water consumption during water softener regeneration in gallons per cycle which includes regeneration, as determined in section 5.4.3 of this appendix,

T = nominal water heater temperature rise = 90 °F, and

K = specific heat of water in kilowatt-hours per gallon per degree Fahrenheit = 0.0024.

5.5.2 *Dishwashers that operate with a nominal inlet water temperature of 120 °F.*

5.5.2.1 Calculate the water energy consumption, W, expressed in kilowatt-hours per cycle and defined as:

$W = V \times T \times K$

where,

V = water consumption in gallons per cycle, as determined in section 5.4.1 of this appendix for non-soil-sensing dishwashers and section 5.4.2 of this appendix for soil-sensing dishwashers,

T = nominal water heater temperature rise = 70 °F, and

K = specific heat of water in kilowatt-hours per gallon per degree Fahrenheit = 0.0024,

5.5.2.2 For water-softening dishwashers, calculate the water softener regeneration water energy consumption, W_{WS}, expressed in kilowatt-hours per cycle and defined as:

$W_{WS} = V_{WS} \times T \times K$

where,

V_{WS} = water consumption during water softener regeneration in gallons per cycle which includes regeneration, as determined in section 5.4.3 of this appendix,

T = nominal water heater temperature rise = 70 °F, and

K = specific heat of water in kilowatt-hours per gallon per degree Fahrenheit = 0.0024.

5.6 *Water energy consumption per cycle using gas-heated or oil-heated water*.

5.6.1 *Dishwashers that operate with a nominal 140 °F inlet water temperature, only*.

5.6.1.1 Calculate the water energy consumption using gas-heated or oil-heated water, W_g, expressed in Btu's per cycle and defined as:

$W_g = V \times T \times C/e$

where,

V = water consumption in gallons per cycle, as determined in section 5.4.1 of this appendix for non-soil-sensing dishwashers and section 5.4.2 of this appendix for soil-sensing dishwashers,

T = nominal water heater temperature rise = 90 °F,

C = specific heat of water in Btu's per gallon per degree Fahrenheit = 8.2, and

e = nominal gas or oil water heater recovery efficiency = 0.75,

5.6.1.2 For water-softening dishwashers, calculate the water softener regeneration water energy consumption, W_{WSg}, expressed in kilowatt-hours per cycle and defined as:

$W_{WSg} = V_{WS} \times T \times C/e$

where,

V_{WS} = water consumption during water softener regeneration in gallons per cycle which includes regeneration, as determined in section 5.4.3 of this appendix,

T = nominal water heater temperature rise = 90 °F,

C = specific heat of water in Btu's per gallon per degree Fahrenheit = 8.2, and

e = nominal gas or oil water heater recovery efficiency = 0.75.

5.6.2 *Dishwashers that operate with a nominal 120 °F inlet water temperature, only*.

5.6.2.1 Calculate the water energy consumption using gas-heated or oil-heated water, W_g, expressed in Btu's per cycle and defined as:

$W_g = V \times T \times C/e$

where,

V = water consumption in gallons per cycle, as determined in section 5.4.1 of this appendix for non-soil-sensing dishwashers and section 5.4.2 of this appendix for soil-sensing dishwashers,

T = nominal water heater temperature rise = 70 °F,

C = specific heat of water in Btu's per gallon per degree Fahrenheit = 8.2, and

e = nominal gas or oil water heater recovery efficiency = 0.75.

5.6.2.2 For water-softening dishwashers, calculate the water softener regeneration water energy consumption, W_{WSg}, expressed in kilowatt-hours per cycle and defined as:

$W_{WSg} = V_{WS} \times T \times C/e$

where,

V_{WS} = water consumption during water softener regeneration in gallons per cycle which includes regeneration, as determined in section 5.4.3 of this appendix,

T = nominal water heater temperature rise = 70 °F,

C = specific heat of water in Btu's per gallon per degree Fahrenheit = 8.2, and

e = nominal gas or oil water heater recovery efficiency = 0.75.

5.7 *Annual combined low-power mode energy consumption*. Calculate the annual combined low-power mode energy consumption for dishwashers, E_{TLP}, expressed in kilowatt-hours per year, according to the following:

$E_{TLP} = [(P_{IA} \times S_{IA}) + (P_{OM} \times S_{OM})] \times K$

where:

P_{IA} = dishwasher inactive mode power, in watts, as measured in section 4.2.1 of this appendix for dishwashers capable of operating in inactive mode; otherwise, P_{IA} = 0,

P_{OM} = dishwasher off mode power, in watts, as measured in section 4.2.2 of this appendix for dishwashers capable of operating in off mode; otherwise, P_{OM} = 0,

S_{IA} = annual hours in inactive mode as defined as S_{LP} if no off mode is possible, $[S_{LP}/2]$ if both inactive mode and off mode are possible, and 0 if no inactive mode is possible,

S_{OM} = annual hours in off mode as defined as S_{LP} if no inactive mode is possible, $[S_{LP}/2]$ if both inactive mode and off mode are possible, and 0 if no off mode is possible,

S_{LP} = combined low-power annual hours for all available modes other than active mode as defined as $[H - (N \times (L + L_F))]$ for dishwashers capable of operating in fan-only mode; otherwise, S_{LP} = 8,465,

H = the total number of hours per year = 8766 hours per year,

N = the representative average dishwasher use of 215 cycles per year,

L = the average of the duration of the normal cycle and truncated normal cycle, for non-soil-sensing dishwashers with a truncated normal cycle; the duration of the normal cycle, for non-soil-sensing dishwashers without a truncated normal cycle; the average duration of the sensor light response, truncated sensor light response, sensor medium response, truncated sensor medium response, sensor heavy response, and truncated sensor heavy response, for soil-sensing dishwashers with a truncated cycle option; the average duration of the sensor light response, sensor medium response, and

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sensor heavy response, for soil-sensing dishwashers without a truncated cycle option,

L_F = the duration of the fan-only mode for the normal cycle for non-soil-sensing dishwashers; the average duration of the fan-only mode for sensor light response, sensor medium response, and sensor heavy response for soil-sensing dishwashers, and

K = 0.001 kWh/Wh conversion factor for watt-hours to kilowatt-hours.

[77 FR 65982, Oct. 31, 2012]

APPENDIX D TO SUBPART B OF PART 430—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF CLOTHES DRYERS

NOTE: Manufacturers must continue to use appendix D to subpart B of part 430 until the energy conservation standards for clothes dryers at 10 CFR 430.32(h) are amended to require mandatory compliance using appendix D1.

1. Definitions

1.1 ''AHAM'' means the Association of Home Appliance Manufacturers.

1.2 ''Bone dry'' means a condition of a load of test clothes which has been dried in a dryer at maximum temperature for a minimum of 10 minutes, removed and weighed before cool down, and then dried again for 10-minute periods until the final weight change of the load is 1 percent or less.

1.3 ''Compact'' or compact size'' means a clothes dryer with a drum capacity of less than 4.4 cubic feet.

1.4 ''Cool down'' means that portion of the clothes drying cycle when the added gas or electric heat is terminated and the clothes continue to tumble and dry within the drum.

1.5 ''Cycle'' means a sequence of operation of a clothes dryer which performs a clothes drying operation, and may include variations or combinations of the functions of heating, tumbling and drying.

1.6 ''Drum capacity'' means the volume of the drying drum in cubic feet.

1.7 ''HLD–1'' means the test standard promulgated by AHAM and titled ''AHAM Performance Evaluation Procedure for Household Tumble Type Clothes Dryers'', June 1974, and designated as HLD–1.

1.8 ''HLD–2EC'' means the test standard promulgated by AHAM and titled ''Test Method for Measuring Energy Consumption of Household Tumble Type Clothes Dryers,'' December 1975, and designated as HLD–2EC.

1.9 ''Standard size'' means a clothes dryer with a drum capacity of 4.4 cubic feet or greater.

1.10 ''Moisture content'' means the ratio of the weight of water contained by the test load to the bone-dry weight of the test load, expressed as a percent.

1.11 ''Automatic termination control'' means a dryer control system with a sensor which monitors either the dryer load temperature or its moisture content and with a controller which automatically terminates the drying process. A mark or detent which indicates a preferred automatic termination control setting must be present if the dryer is to be classified as having an ''automatic termination control.'' A mark is a visible single control setting on one or more dryer controls.

1.12 ''Temperature sensing control'' means a system which monitors dryer exhaust air temperature and automatically terminates the dryer cycle.

1.13 ''Moisture sensing control'' means a system which utilizes a moisture sensing element within the dryer drum that monitors the amount of moisture in the clothes and automatically terminates the dryer cycle.

2. Testing Conditions

2.1 *Installation.* Install the clothes dryer in accordance with manufacturer's instructions. The dryer exhaust shall be restricted by adding the AHAM exhaust simulator described in 3.3.5 of HLD–1. All external joints should be taped to avoid air leakage. Disconnect all console light or other lighting systems on the clothes dryer which do not consume more than 10 watts during the clothes dryer test cycle.

2.2 *Ambient temperature and humidity.* Maintain the room ambient air temperature at 75 ±3 °F and the room relative humidity at 50±10 percent relative humidity.

2.3 Energy supply.

2.3.1 *Electrical supply.* Maintain the electrical supply at the clothes dryer terminal block within 1 percent of 120/240 or 120/208Y or 120 volts as applicable to the particular terminal block wiring system and within 1 percent of the nameplate frequency as specified by the manufacturer. If the dryer has a dual voltage conversion capability, conduct test at the highest voltage specified by the manufacturer.

2.3.2 *Gas supply.*

2.3.2.1 *Natural gas.* Maintains the gas supply to the clothes dryer at a normal inlet test pressure immediately ahead of all controls at 7 to 10 inches of water column. If the clothes dryer is equipped with a gas appliance pressure regulator, the regulator outlet pressure at the normal test pressure shall be approximately that recommended by the manufacturer. The hourly Btu rating of the burner shall be maintained within ±5 percent of the rating specified by the manufacturer. The natural gas supplied should have a heating value of approximately 1,025 Btu's per standard cubic foot. The actual heating value, H_n2, in Btu's per standard cubic foot, for the natural gas to be used in the test